



Injury Report 2014 - Cricket Australia

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Authors: **John Orchard**, Chief Medical Officer, Cricket Australia
Alex Kountouris, Physiotherapist, Australian cricket team
Kevin Sims, Physiotherapist, National Cricket Centre, Cricket Australia
Jessica Orchard, Adjunct Lecturer, School of Public Health, University of Sydney
David Beakley, Physiotherapist, National Cricket Centre
Peter Brukner, Doctor, Australian cricket team

1 Summary

This report analyses injuries occurring prospectively in Australian cricket at the men's state and national levels over the last 9 years in particular, concluding in season 2013-14, which is the recent focus of the report. It also compares this 9 year period ("T20 era") with the previous 9 years (starting 1996-97) to analyse long-term trends of injury.

1.1 Season 2013-14

This report confirms the trend reported by AMS analysis earlier this year that 2013-14 was a season with relatively low injury prevalence at state/overall (10.8%) and national team (10.8%) level. These are both the lowest figures recorded since season 2006-07.

At national level it was not unexpected to have low recorded injury prevalence in a season (2013-14) where the Australian national men's team was very successful, particularly in Test cricket. Winning cricket is usually associated with lower risk of injury, as there is less necessity for fast bowlers to over-bowl (from an injury prevention perspective, suddenly increase their workloads) if the opposition is being dismissed quickly and if the team's own batsmen are spending long periods occupying the crease.

At domestic level a major change in the schedule occurred in 2013-14 with the domestic one day competition being held as a stand-alone fixture at the start of the cricket season. This substantially reduced the number and frequency of format changes (moving back and forth from one day to Shield) for players. Our recently published research suggests that change in workload is perhaps the greatest risk factor for injury in fast bowlers and hence the format change for the domestic one day competition in theory should assist in reducing injuries. In practice, 2013-14 showed lower injury rates than in previous years and we hope that this trend will continue if the new format remains in place.

1.2 The T20 era compared with the pre-T20 era

The number of Test, first class, ODI and List A matches was essentially unchanged from the pre-T20 era to the T20 era, but there was a 35% increase in the number of overall matches played, with the increase entirely being T20 matches. There was only a minimal effect on overall number of overs bowled, however, with T20 giving rise to far fewer overs than the longer forms of the game. The challenges to bowlers were of rapid changes in weekly workloads and an increase in overall number of fixtures rather than an increase in annual workloads.

The T20 era was generally associated with increased risk of injury. For match injury incidence (number of injuries per squad per season) overall, there was a 1.18 relative risk in the T20 era (95% CI 1.03-1.35) compared to the pre-T20 era. For match bowling injuries overall, there was a 1.28 relative risk in the T20 era (significant, 95% CI 1.05-1.54). In the T20 era there was also a significant increase in seasonal injuries for all teams combined RR 1.13 (95% CI 1.04-1.22). Of the individual injury categories, only thigh and hamstring strains (RR 1.44, 95% CI 1.18-1.76) and other shoulder (not tendon) injuries (RR 1.66 95% CI 1.02-2.68) increased significantly in incidence in the T20 era.

Injury prevalence (percentage of players missing through injury) increased far more than injury incidence in the T20 era, meaning that average severity (number of games missed

per individual injury) increased. The major reason for more games being missed in the T20 era is simply that the games were scheduled in closer proximity to each other to fit the T20 games into the calendar. The injury prevalence overall significantly increased for the T20 era (RR 1.41 95% CI 1.37-1.45). The injury prevalence for every position increased significantly in the T20 era. In absolute terms it increased most for fast bowlers from 15.2% to 19.9% (a 4.7% increase). However in relative terms the increase for fast bowlers was the least of all positions. Batsmen, spin bowlers and wicketkeepers all had absolute increases of injury prevalence of approximately 3% in the T20 era but coming off a low base in the T20 era their relative injury prevalence compared to pre-T20 era was much higher. For example, spin bowlers increased from 4.1% to 7.2% average injury prevalence in the T20 era.

The notable injury categories which led to more missed playing time in the T20 era were: Other (non-tendon) shoulder injuries RR 1.55 95% CI (1.35-1.78), Wrist and hand fractures RR 1.35 95% CI (1.21-1.52), Side and abdominal strains RR 1.48 95% CI (1.33-1.65), Lumbar stress fractures RR 1.69 95% CI (1.56-1.84), Thigh and hamstring strains RR 2.08 95% CI (1.90-2.27) and Shin and foot stress fractures RR 1.75 95% CI (1.52-2.00).

The notable injury categories which led to less missed playing time in the T20 era were: Medical illness RR 0.55 95% CI (0.47-0.66) and Arm/forearm fractures RR 0.38 95% CI (0.24-0.62).

1.3 Recommended changes to international cricket consensus definitions

This report is still based primarily on the 2005 cricket consensus definitions. It can and will be used as a discussion point at the 2015 World Congress on Cricket in Sydney, to recommend changes to a new set of consensus definitions. In particular the major items that need *consideration* for change are:

(1) New injury definitions for tournament cricket to allow comparison of tournaments like World Cups, IPL, Big Bash (perhaps including injuries which require medical treatment but do not cause missed playing time).

(2) An ability to differentiate injury prevalence in matches only (currently used and laborious to calculate) from daily injury prevalence at all times (easy to calculate automatically from systems such as the AMS). Match injury prevalence is more important and accurate but the ease of calculation of daily injury prevalence for all teams/countries will make this a useful reference figure.

(3) Change in injury categories. Due to increase in shoulder instability, hamstring strains and hip joint lesions, these items need separate (distinct) injury categories in future reports. Although not common, concussion needs a separate category for political reasons.

(4) Other items related to T20 cricket. For example, in the 2005 definitions a bowler was defined as a player who regularly bowled 5 or more overs in matches, which would not allow any T20 specialist player to be considered a bowler.

1.4 Summary of key findings

- **Change in workload a key risk for fast bowling injuries:** our recently published research suggests that sudden change in workload is probably the greatest risk factor for injury in fast bowlers. Tendon injuries are most affected, and are more susceptible to injury with sudden upgrades to high bowling workloads (e.g bowling 5 overs in a T20 match then soon after bowling 50 overs in Test cricket). Therefore, consistent bowling workloads reduce the risk of tendon injuries. In addition, for young fast bowlers gradual upgrades in workload are recommended to reduce the risk of bone stress injuries.
- **Injuries in season 2013-14 at a 7 year low:** season 2013-14 was a season with relatively low injury prevalence at state/overall (10.8%) and national team (10.8%) level. These are both the lowest figures recorded since season 2006-07.
- Possible reasons for the low injury figures:
 - At national level, the Australian national men's team was very successful, particularly in Test cricket. Winning cricket is usually associated with lower risk of injury, as there is often less need for fast bowlers to over-bowl and risk getting injured from the sudden increase in workload. This happens if the opposition is being dismissed quickly and if the team's own batsmen are spending long periods occupying the crease.
 - At domestic level, a major change in the schedule occurred in 2013-14 with the domestic one day competition being held as a stand-alone fixture at the start of the cricket season. This substantially reduced the number and frequency of format changes (moving back and forth from one day to Shield) for players. As changes in workload are a key risk factor for fast bowling injuries, the format change for the domestic one day competition should assist in reducing injuries.
- **The T20 era compared with the pre-T20 era**
 - **Increase in matches played:** The number of Test, first class, ODI and List A matches was essentially unchanged from the pre-T20 era to the T20 era, but there was a 35% increase in the number of overall matches played, with the increase entirely being T20 matches. The challenge for bowlers was the rapid changes in weekly workloads rather than an increase in annual workloads.
 - **Increased risk of injury in the T20 era:** The T20 era was generally associated with increased risk of injury.
 - *Injuries during matches:* For match injury incidence (number of injuries during a match per squad per season) overall, there was an 18% higher chance of injury in the T20 era compared to the pre-T20 era. For match bowling injuries overall, there was a 28% higher risk in the T20 era.
 - *Injuries during the whole season:* In the T20 era there was also a 13% increase in seasonal injuries for all teams combined. However, the only individual categories of injuries that increased in the T20 era were thigh and hamstring strains and other shoulder (not tendon) injuries.
 - *Overall injury prevalence:* Overall injury prevalence increased in the T20 era as injured players missed more games – the major reason for this is that the games were scheduled more closely to fit the T20 games into the calendar.
 - *Injuries by position:* Injury prevalence for each position also increased significantly in the T20 era. The largest absolute increase was a 4.7% increase for fast bowlers. Batsmen, spin bowlers and wicketkeepers all had absolute increases of injury

prevalence of approximately 3% in the T20 era, but coming off a low base in the T20 era their relative injury prevalence compared to pre-T20 era was much higher. For example, spin bowlers increased from 4.1% to 7.2% average injury prevalence in the T20 era whereas fast bowlers increased from 15.2% to 19.9%.

- *Types of injuries:* Injuries that caused players to miss more playing time in the T20 era were shoulder injuries (non-tendon), wrist and hand fractures, side and abdominal strains, low-back stress fractures, thigh and hamstring strains and shin and foot stress fractures.

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2 Introduction

The first major series of published studies on cricket injuries were made in the late 1980s and early 1990s, with the earliest attempts at recording larger series of injuries [1-4] and exploring risk factors for lumbar injuries in fast bowlers [5-11]. Cricket researchers published the first ever consensus international injury definitions for a sport in 2005, co-published in four major sports medicine journals [12-15], a process that was driven by the leadership that Australia had shown in developing a successful and ongoing injury surveillance system [16]. Other team sports such as football (soccer), in 2006 [17] and rugby union, in 2007 [18] also published consensus definitions. The process for determining the consensus definitions in 2004 was to use the existing Australian definitions as a default but for authors from other countries – themselves generally in the process of trying to set up injury surveillance systems – to make suggestions and modifications to try to improve the process and results. The international definitions have been a qualified success in that since their publication there have been subsequent publications of injury surveillance results from the West Indies [19], Australia [20-21], New Zealand.[22]

There have been some major changes to both the cricket calendar and the way that cricket injuries are managed and understood. These are:

(1) The explosion of T20 cricket as a major format of the game. T20 cricket had been played in England at domestic level prior to 2005, but subsequent to this time it has quickly become a very prominent form of the game in terms of number of matches, crowds and television ratings.

(2) The increased number of teams that an average player represents. Prior to 2005 an Australian player might represent his state and country with a minority of players occasionally playing county cricket in the off-season in England. In the T20 era many Australian players will play for four teams – state, country, Big Bash team and Indian Premier League (IPL) or English county/domestic T20 team. There are some players who are T20 specialists who can represent 5 or 6 teams in a single year. The implications are that it is more common for an injury sustained playing for one team to affect availability for another team.

(3) The understanding that “overuse” injuries often don’t occur in a specific match but are as a result of gradual failure to withstand increasing load over an extended time period [23-24]. Because so many injuries in cricket are of this gradual onset nature, some traditional measures of injury incidence (e.g. injury per player match) become harder to apply, because a match onset is not easily attributed to many types of cricket injury.

(4) The emergence of server-based injury recording systems. In 2005 the injury details for specific injuries needed to be communicated (often at the end of the season) from team staff to injury surveillance coordinator. A decade later, Australia (and many other countries) have monitoring systems that capture most injuries and illnesses that present to medical staff almost instantaneously. There is the potential for more injuries to be captured in modern recording systems, but the debate about reliability still applies [25-28].

3 Methods

3.1 Injury definitions

Methods for the survey have been described previously [12 14 16 20] but are summarised below.

The definition of a cricket injury (or 'relevant' injury for surveillance purposes) is:

Any injury or other medical condition that either:

- (1) prevents a player from being fully available for selection in a major match; or
- (2) during a major match, causes a player to be unable to bat, bowl or keep wicket when required by either the rules or the team's captain.

The major injury rates presented are injury incidence and injury prevalence:

- Injury incidence analyses the number of injuries occurring over a given time period.
- Injury match incidence considers only those injuries occurring during major matches. The preferred unit in this report is injuries per 1000 days of play, which was not the recommended unit in the 2005 definitions but is more suitable to compare the various formats in the era of T20 cricket.
- Injury seasonal incidence considers the number of defined injuries occurring per squad per season. This can take into account gradual onset injuries, training injuries and match injuries in the one measurement. A 'squad' is defined as 25 players and a 'season' is defined as 60 days of scheduled match play.

Injury prevalence considers the average number of squad members not available for selection through injury for each match divided by the total number of squad members. Injury prevalence is expressed as a percentage, representing the percentage of players missing through injury on average for that team for the season in question. It is calculated using the numerator of 'missed player games', with a denominator of number of games multiplied by squad members. Player movement monitoring essentially requires that all players are defined in each match as either: (1) playing cricket (2) not playing cricket due to injury or illness (3) not playing cricket for another reason (e.g. non-selection with no lower grade game available).

This report covers injuries from the following cricket seasons:

Table 1 - Dates of seasons covered by this survey (* Ashes tours)

| Year | Season | Dates | Year | Season | Dates |
|-------|---------|-----------------------|------|---------|--------------------|
| T20-9 | 2013-14 | Jun 2013-Apr 2014* | P9 | 2004-05 | May 2004-Mar 2005 |
| T20-8 | 2012-13 | Jun 2012-Mar 2013 | P8 | 2003-04 | Jul 2003-Mar 2004 |
| T20-7 | 2011-12 | Aug 2011-Apr 2012 | P7 | 2002-03 | Jun 2002-Apr 2003 |
| T20-6 | 2010-11 | May 2010-Apr 2011 | P6 | 2001-02 | Jun 2001-Apr 2002* |
| T20-5 | 2009-10 | May 2009-Mar 2010* | P5 | 2000-01 | Aug 2000-Apr 2001 |
| T20-4 | 2008-09 | Sep 2008-Apr 2009 | P4 | 1999-00 | May 1999-Apr 2000 |
| T20-3 | 2007-08 | Sep 2007-Mar 2008 | P3 | 1998-99 | Oct 1998-Apr 1999 |
| T20-2 | 2006-07 | Sep 2006-Apr 2007 | P2 | 1997-98 | May 1997-Apr 1998* |
| T20-1 | 2005-06 | June 2005-April 2006* | P1 | 1996-97 | Aug 1996-Apr 1997 |

In order to promote consistency, the starting date for the Australian cricket year has been designated as the start of whichever series was being played after May 1st for every season under consideration (Table 1).

Some of the injury rates reported here for seasons prior to 2012-13 may vary slightly from those published in previous reports. If input errors were found or definitions of injury categories have been changed then the updated values for previous seasons are included in this report. Therefore this report reflects the most accurate data from past seasons and the values presented here supersede all previous publications.

The methods used for Cricket Australia injury surveillance conform to the Code of Ethics of the World Medical Association (Declaration of Helsinki) and the latest National Health and Medical Research Council (NHMRC) guidelines for research. They have been approved by the Cricket Australia Sports Science Sports Medicine Advisory Group as the relevant institutional review board. As injury surveillance is non-interventional and the methods preserve confidentiality of the players, it is characterised as 'low or negligible risk' (statement available at:

http://www.nhmrc.gov.au/files_nhmrc/file/publications/synopses/e72-jul09.pdf

accessed December 9, 2013).

3.2 Statistical calculations

Data presented in this report is categorised into pre-T20 era 9 year averages and T20-era 9 year averages. The two eras are statistically compared to give relative risks (RR) of injuries between eras. The 95% CI of the RR are calculated using Taylor Series expansions [29].

4 Results

4.1 Injury exposure calculations

Table 2 lists the number of players in each squad per season and Table 3 lists the number of matches per team per season. Since 1998-99, the Australian team has contracted players annually prior to the start of any winter tours although it includes (from the date of their first match until the new round of contracts) any other player who tours with or plays in the Australian team. State teams can contract up to 20 other players on regular contracts (outside their Australian contracted players) and up to 6 players on 'rookie' contracts. As with the Australian team, any other player who plays with the team in a major match during the season is designated as a squad member from that time on. Prior to 2011-12, players who have been contracted to play Twenty-20 matches only for a state have been included as regular players according to the international definition. From 2011-12 onwards, T20 players have been signed by franchises only and therefore are not considered as 'state' players.

Table 2 - Squad numbers per season (T20 era)

| Squad | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 |
|-------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Australia | 30 | 31 | 28 | 40 | 40 | 40 | 42 | 43 | 44 |
| New South Wales | 37 | 40 | 35 | 38 | 38 | 38 | 38 | 28 | 29 |
| Queensland | 31 | 32 | 32 | 33 | 28 | 32 | 30 | 30 | 26 |
| South Australia | 26 | 27 | 30 | 29 | 28 | 31 | 32 | 25 | 28 |
| Tasmania | 27 | 32 | 29 | 27 | 28 | 30 | 29 | 27 | 27 |
| Victoria | 36 | 31 | 25 | 26 | 32 | 33 | 29 | 30 | 30 |
| Western Australia | 37 | 34 | 32 | 34 | 32 | 35 | 31 | 29 | 29 |
| Adelaide | | | | | | | 21 | 21 | 21 |
| Brisbane | | | | | | | 20 | 21 | 24 |
| Hobart | | | | | | | 19 | 19 | 19 |
| Melb Ren'gs | | | | | | | 18 | 21 | 21 |
| Melb Stars | | | | | | | 19 | 19 | 20 |
| Perth | | | | | | | 22 | 25 | 27 |
| Syd Sixers | | | | | | | 20 | 25 | 20 |
| Syd Thunder | | | | | | | 19 | 21 | 22 |

The format of the Sheffield Shield since 1998-99 has consistently been that each of six teams plays ten matches each, one home and one away against each of the other teams (60 team matches), followed by a final (2 team matches) at the end of the season. The matches are all scheduled for 4 days, with the final being scheduled for 5 days. The

major change in Shield scheduling in recent seasons has been to compact the match schedule (particularly prior to Christmas) to allow for a discrete 'window' for the Big Bash tournament. The average number of days between Shield games has therefore decreased.

From 2000-01 until 2011-12, the domestic limited overs (one day) competition (now Ryobi/Matador BBQ Cup) followed the same home & away format as the Sheffield Shield (although it reduced from season 2011-12). In 2013-14 the domestic one day competition was played early in the season as a standalone tournament. The domestic T20 competition (currently KFC Big Bash) commenced in season 2005-06 as a limited round of matches but has been expanded in each subsequent season. Season 2009-10 included a further expansion to the calendar as Champions League Twenty-20 matches were played for two Australian domestic teams. This competition became the Big Bash League in 2011-12 and was expanded to 8 franchise rather than state-based teams. As seen from

Table 4, in limited overs matches, the number of team days is generally the same as the number of team matches scheduled, with the exception of washed out games which count as zero days of exposure.

Table 3 - Team matches under survey from 2005-06 to 2013-14

| | Av 96-7 to 04-5 | Av 05-6 to 13-14 | 2005- 06 | 2006- 07 | 2007- 08 | 2008- 09 | 2009- 10 | 2010- 11 | 2011- 12 | 2012- 13 | 2013- 14 |
|-----------------------|--------------------------|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Champions League T20 | | 9.4 | | | | | 11 | 9 | 9 | 10 | 8 |
| Domestic T20 | | 42.4 | 14 | 26 | 32 | 34 | 34 | 40 | 62 | 70 | 70 |
| Domestic One Day | 52.4 | 56.9 | 62 | 62 | 62 | 62 | 62 | 62 | 50 | 50 | 40 |
| Domestic First Class | 62.0 | 62.0 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 | 62 |
| International T20 | 0.1 | 8.6 | 3 | 1 | 11 | 6 | 10 | 12 | 8 | 13 | 13 |
| One Day International | 27.0 | 27.4 | 35 | 36 | 20 | 23 | 39 | 29 | 24 | 20 | 23 |
| Test match | 12.0 | 11.3 | 17 | 5 | 6 | 15 | 13 | 9 | 14 | 10 | 13 |
| All matches | 153.6 | 213.9 | 193 | 192 | 193 | 202 | 231 | 223 | 229 | 235 | 229 |

Table 4 – Team days played under survey 2005-06 to 2013-14

| | Av 96-7 to 04-5 | Av 05-6 to 13-14 | 2005- 06 | 2006- 07 | 2007- 08 | 2008- 09 | 2009- 10 | 2010- 11 | 2011- 12 | 2012- 13 | 2013- 14 |
|-----------------------|--------------------------|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Champions League T20 | 0.0 | 9.4 | 0 | 0 | 0 | 0 | 11 | 9 | 9 | 10 | 8 |
| Domestic T20 | 0.0 | 42.0 | 14 | 24 | 30 | 34 | 34 | 40 | 62 | 70 | 70 |
| Domestic One Day | 52.0 | 56.4 | 60 | 62 | 60 | 62 | 62 | 62 | 50 | 50 | 40 |
| Domestic First Class | 231.8 | 233.1 | 228 | 232 | 236 | 234 | 240 | 228 | 232 | 224 | 244 |
| International T20 | 0.1 | 8.4 | 3 | 1 | 11 | 6 | 10 | 12 | 8 | 13 | 12 |
| One Day International | 26.7 | 27.1 | 35 | 36 | 20 | 23 | 39 | 27 | 24 | 19 | 21 |
| Test match | 51.3 | 50.9 | 78 | 22 | 28 | 72 | 58 | 41 | 61 | 42 | 56 |
| Total | 361.9 | 423.2 | 418 | 377 | 385 | 431 | 454 | 419 | 446 | 428 | 451 |

As per the international definitions [12-15], hours of player exposure in matches is calculated by multiplying the number of team days of exposure by 6.5 for the average number of players on the field and then multiplied by the number of designated hours in a day's play. However, as detailed in a recent publication [21], this report will use a new unit of match injuries (per 1000 days of play,

Table 4) which more fairly compares T20 cricket to other forms of the game. This is used as the denominator for Table 6 in the injury incidence section.

Table 5 - Overs bowled in matches each season 2005-06 to 2013-14

| | Av 98-9 to 04-5 | Av 05-6 to 13-14 | 2005- 06 | 2006- 07 | 2007- 08 | 2008- 09 | 2009- 10 | 2010- 11 | 2011- 12 | 2012- 13 | 2013- 14 |
|-----------------------|--------------------------|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Champions League T20 | 0 | 89 | 0 | 0 | 0 | 0 | 210 | 175 | 154 | 173 | 97 |
| Domestic T20 | 0 | 782 | 241 | 470 | 570 | 659 | 615 | 730 | 1181 | 1296 | 1272 |
| Domestic One Day | 2510 | 2533 | 2751 | 2877 | 2606 | 2751 | 2846 | 2546 | 2315 | 2238 | 1869 |
| Domestic First Class | 9821 | 9707 | 9645 | 9967 | 9713 | 9974 | 9745 | 9297 | 9511 | 9093 | 10419 |
| International T20 | 3 | 151 | 58 | 20 | 171 | 121 | 152 | 224 | 158 | 232 | 223 |
| One Day International | 1204 | 1154 | 1577 | 1488 | 805 | 959 | 1657 | 1226 | 1040 | 721 | 911 |
| Test match | 1945 | 1917 | 2756 | 890 | 1136 | 2833 | 2116 | 1419 | 2128 | 1728 | 2250 |
| Total overs | 15483 | 16334 | 17027 | 15711 | 15001 | 17299 | 17341 | 15617 | 16488 | 15481 | 17041 |

Table 5 shows that workload in terms of number of overs bowled has stayed fairly steady in first class domestic cricket over the past 18 years. The overall number of Australian first class and 'List A' overs bowled reached an all-time high in season 2009-10, but has plateaued since. The ongoing expansion of T20 cricket itself does not substantially increase overall match bowling workload. However, two 'knock-on' effects of T20 cricket have probably been highly significant (but are somewhat harder to measure) – increased variability in workloads and increased compression of first class fixtures to accommodate the T20 calendar.

4.2 Injury incidence

Injury incidence results are detailed in Table 6- Table 9. Injury match incidence is calculated in Table 6 using the total number of injuries (both new and recurrent) as the numerator and the number of days of play (

Table 4) as the denominator. Injury match incidence is probably a flawed way to examine injury risk, because the genesis of fast bowling injuries is often prior workload patterns[30]. For example, the home summer ODI competition traditionally has the highest injury rate of the Australian calendar, yet we now understand that the reason for this is fatigue from the prior Test matches in the lead up to the ODI schedule. One Day cricket played over an extended period (e.g. in World Cups) consistently leads to fewer injuries than Test cricket.

Table 6 - Injury match incidence (new and recurrent injuries/1000 days of play)

| | Av 96-7 to 04- 5 | Av 05-6 to 13- 14 | 2005- 06 | 2006- 07 | 2007- 08 | 2008- 09 | 2009- 10 | 2010- 11 | 2011- 12 | 2012- 13 | 2013- 14 |
|---------------------------|---------------------------|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Champions League T20 * | | 127.7 | | | | | 0.0 | 222.2 | 111.1 | 200.0 | 125.0 |
| Domestic T20 | | 166.7 | 71.4 | 208.3 | 200.0 | 117.6 | 117.6 | 400.0 | 112.9 | 171.4 | 114.3 |
| Domestic One Day | 177.4 | 285.4 | 283.3 | 209.7 | 233.3 | 354.8 | 290.3 | 322.6 | 196.4 | 83.3 | 225.0 |
| Domestic First Class | 106.4 | 120.6 | 57.0 | 112.1 | 152.5 | 149.6 | 91.7 | 157.9 | 131.2 | 73.0 | 114.8 |
| International T20 * | | 189.2 | 3333.3 | 0.0 | 5555.6 | 0.0 | 100.0 | 166.7 | 8.3 | 8.4 | 83.3 |
| One Day International | 270.8 | 245.9 | 85.7 | 222.2 | 200.0 | 217.4 | 256.4 | 407.4 | 156.3 | 250.0 | 285.7 |
| Test match | 123.4 | 102.6 | 89.7 | 90.9 | 142.9 | 83.3 | 69.0 | 122.0 | 105.9 | 65.6 | 107.1 |
| All matches | 131.1 | 154.5 | 100.5 | 143.2 | 180.2 | 167.1 | 130.0 | 219.6 | 163.7 | 123.4 | 130.8 |

*Sample sizes for International and CLT20 are very small hence varying results

For overall match incidence and for the various games formats, there were few significant differences (at 95% CI level) between the pre-T20 and T20 eras, although there were trends towards more injuries in the T20 era. For matches injuries overall, there was a 1.18 relative risk in the T20 era (95% CI 1.03-1.35). Domestic one day matches (RR 1.61, 95% CI 1.20-2.17) was the one match format with a significantly increased risk of injuries. For domestic first class matches (RR 1.13, 95% CI 0.94-1.37) there was a trend towards more bowling injuries in the T20 era. Of course T20 matches themselves could not be compared between eras.

Table 7 - Bowling match incidence (new and recurrent match injuries/1000 overs bowled)

| | Av 96-7 to 04-5 | Av 05-6 to 13- 14 | 2005 -06 | 2006 -07 | 2007 -08 | 2008 -09 | 2009 -10 | 2010 -11 | 2011 -12 | 2012 -13 | 2013 -14 |
|-----------------------|--------------------------|-------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Champions League T20 | | 2.5 | | | | | 0.0 | 11.4 | 0.0 | 0.0 | 0.0 |
| Domestic T20 | | 2.0 | 0.0 | 2.1 | 1.8 | 3.0 | 0.0 | 6.9 | 0.8 | 2.3 | 0.8 |
| Domestic One Day | 1.9 | 2.8 | 1.1 | 1.4 | 2.7 | 3.6 | 3.9 | 4.3 | 3.5 | 2.7 | 1.6 |
| Domestic First Class | 1.2 | 1.6 | 0.2 | 1.1 | 2.2 | 2.3 | 1.2 | 2.3 | 2.5 | 1.2 | 1.4 |
| International T20 | | 3.7 | 0.0 | 0.0 | 5.8 | 0.0 | 6.6 | 4.5 | 0.0 | 8.6 | 0.0 |
| One Day International | 1.6 | 2.2 | 0.6 | 2.0 | 0.0 | 1.0 | 3.6 | 4.1 | 1.0 | 5.5 | 2.2 |
| Test match | 1.8 | 1.1 | 0.7 | 1.1 | 0.0 | 0.7 | 0.5 | 1.4 | 2.3 | 1.7 | 1.3 |
| All matches | 1.4 | 1.8 | 0.5 | 1.3 | 2.0 | 2.2 | 1.8 | 2.9 | 2.4 | 1.9 | 1.4 |

For overall bowling match incidence and for the various games formats, there was some significant different (at 95% CI level) between the pre-T20 and T20 eras. For match bowling injuries overall, there was a 1.28 relative risk in the T20 era (significant, 95% CI 1.05-1.54). For domestic one day matches (RR 1.46, 95% CI 0.94-2.17) and domestic first class matches (RR 1.35, 95% CI 1.03-1.74) there was a trend towards more bowling injuries in the T20 era, but for Test cricket there was a trend towards fewer bowling match injuries in the T20 era (RR 0.60, 95% CI 0.37-1.06).

Table 6 analyses match injury incidence by the unit of injuries per 1000 days of play. These units were not recommended by the international definitions, but enable a more direct comparison between T20 cricket and the other forms. From Table 7, it can be seen that Domestic T20 matches have a similar bowling injury incidence than other forms of domestic cricket in terms of injuries per day of play as well as injuries per 1000 overs bowled. The international and Champions League T20 figures follow a similar trend although are not yet as accurate due to the small sample size.

Seasonal incidence

Seasonal incidence (Table 8 and Table 9) is calculated by number of injuries multiplied by 1500 (for a squad of 25 players over 60 days), divided by the number of player days of exposure. The seasonal incidence was high over the time 2010-11 to 2012-13 but has dropped in 2013-14.

In the T20 era there was a significant increase in seasonal injuries for all teams RR 1.13 (95% CI 1.04-1.22) and for the NSW team although not for any other individual teams.

Table 8 - Injury seasonal incidence by team (injuries/team/season)

| | Av 96-7 to 04-5 | Av 05-6 to 13- 14 | 2005 -06 | 2006 -07 | 2007 -08 | 2008 -09 | 2009 -10 | 2010 -11 | 2011 -12 | 2012 -13 | 2013 -14 |
|-----------------------------|--------------------------|-------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Australia | 17.4 | 18.5 | 16.2 | 26.2 | 25.0 | 16.8 | 14.3 | 21.7 | 18.2 | 21.9 | 14.7 |
| New South Wales | 13.1 | 17.0 | 8.9 | 15.0 | 8.5 | 18.6 | 13.8 | 23.4 | 26.4 | 29.9 | 12.1 |
| Queensland | 18.2 | 22.2 | 16.0 | 20.6 | 36.3 | 17.5 | 9.6 | 27.4 | 24.8 | 15.2 | 36.6 |
| South Australia | 16.7 | 18.0 | 17.3 | 12.7 | 17.5 | 21.5 | 18.2 | 22.5 | 20.8 | 17.9 | 11.0 |
| Tasmania | 16.7 | 14.7 | 21.7 | 10.7 | 11.6 | 11.8 | 15.9 | 13.0 | 25.4 | 15.1 | 8.8 |
| Victoria | 17.6 | 17.8 | 15.9 | 19.5 | 29.0 | 19.6 | 17.0 | 15.4 | 15.0 | 14.9 | 13.8 |
| Western Australia | 17.3 | 17.3 | 11.1 | 12.4 | 16.3 | 17.0 | 6.6 | 23.9 | 22.7 | 28.1 | 22.2 |
| Big Bash teams (avg) | | 40.7 | | | | | | | 48.4 | 45.3 | 30.2 |
| All teams | 16.7 | 18.9 | 15.1 | 16.7 | 20.0 | 17.5 | 13.8 | 21.1 | 23.9 | 24.0 | 18.3 |

Table 9 - Injury seasonal incidence by body area & injury type

| Injury type | Av 96-7 to 04-5 | Av 05-6 to 13-14 | 2005- 06 | 2006- 07 | 2007- 08 | 2008- 09 | 2009- 10 | 2010- 11 | 2011- 12 | 2012- 13 | 2013- 14 |
|-------------------------------------|--------------------------|---------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Fractured facial bones | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.3 | 0.1 | 0.2 | 0.3 | 0.1 | 0.0 |
| Other head and facial injuries | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.2 |
| Neck injuries | 0.1 | 0.1 | 0.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Shoulder tendon injuries | 0.6 | 0.5 | 0.9 | 0.6 | 0.5 | 0.2 | 0.3 | 0.3 | 0.7 | 0.1 | 0.2 |
| Other shoulder injuries | 0.4 | 0.7 | 0.8 | 0.5 | 1.5 | 0.3 | 0.4 | 0.3 | 0.8 | 0.7 | 1.1 |
| Arm/forearm fractures | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Other elbow/arm injuries | 0.3 | 0.4 | 0.6 | 0.3 | 0.9 | 0.3 | 0.4 | 0.8 | 0.3 | 0.1 | 0.0 |
| Wrist and hand fractures | 1.1 | 1.2 | 0.8 | 0.5 | 1.3 | 1.0 | 1.2 | 2.7 | 1.0 | 1.5 | 1.0 |
| Other wrist/hand injuries | 0.6 | 0.8 | 0.4 | 0.5 | 0.4 | 0.9 | 0.6 | 1.3 | 0.8 | 1.6 | 0.5 |
| Side and abdominal strains | 1.3 | 1.6 | 0.6 | 1.6 | 1.7 | 1.4 | 1.4 | 1.2 | 2.0 | 2.4 | 2.0 |
| Other trunk injuries | 0.2 | 0.4 | 0.6 | 0.6 | 0.1 | 0.1 | 0.3 | 0.3 | 0.6 | 0.4 | 0.2 |
| Lumbar stress fractures | 0.6 | 0.9 | 0.4 | 0.9 | 0.3 | 0.6 | 0.8 | 1.2 | 1.4 | 1.1 | 1.3 |
| Other lumbar injuries | 1.3 | 1.3 | 1.7 | 1.0 | 1.6 | 1.3 | 0.9 | 1.7 | 2.0 | 0.8 | 0.7 |
| Groin and hip injuries | 1.2 | 1.3 | 1.2 | 1.4 | 1.1 | 1.0 | 0.5 | 1.7 | 1.8 | 2.1 | 1.1 |
| Thigh and hamstring strains | 2.6 | 3.7 | 1.3 | 1.9 | 4.4 | 5.0 | 2.9 | 2.8 | 4.9 | 5.8 | 4.6 |
| Buttock and other thigh injuries | 0.2 | 0.4 | 0.0 | 0.8 | 0.5 | 0.3 | 0.3 | 0.5 | 0.5 | 0.8 | 0.4 |
| Knee cartilage injuries | 0.9 | 0.9 | 1.7 | 0.9 | 0.5 | 0.5 | 1.4 | 0.9 | 0.2 | 0.5 | 1.1 |
| Other knee injuries | 0.7 | 0.5 | 0.6 | 0.4 | 0.3 | 0.3 | 0.4 | 0.2 | 1.0 | 0.9 | 0.4 |
| Shin and foot stress fractures | 0.4 | 0.6 | 0.1 | 0.5 | 0.5 | 0.9 | 0.1 | 0.6 | 0.9 | 1.2 | 0.8 |
| Ankle and foot sprains | 1.0 | 0.8 | 0.5 | 0.9 | 1.2 | 1.2 | 0.4 | 1.2 | 0.9 | 0.8 | 0.2 |
| Other shin, foot and ankle injuries | 1.4 | 1.6 | 0.7 | 1.6 | 1.3 | 1.3 | 1.0 | 2.3 | 2.7 | 2.0 | 1.8 |
| Heat-related illness | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Medical illness | 1.0 | 0.8 | 1.5 | 1.0 | 1.3 | 0.3 | 0.2 | 0.7 | 1.0 | 0.4 | 0.5 |

Of the individual injury categories, only thigh and hamstring strains (RR 1.44, 95% CI 1.18-1.76) and other shoulder (not tendon) injuries (RR 1.66 95% CI 1.02-2.68) have increased significantly in incidence in the T20 era.

4.3 Injury prevalence

Injury prevalence rates (Table 10- Table 13) has generally increased over the T20 era of cricket, with 2010-11 and 2011-12 showing the highest rates. However the injury prevalence rate in 2013-14 was reduced and back in keeping more with rates from the mid-late 2000s (although still higher than pre-T20 era).

Table 10 - Comparison of injury prevalence between teams 2005-06 to 2013-14

| | Av 96-7 to 04-5 | Av 05-6 to 13- 14 | 2005 -06 | 2006- 07 | 2007 -08 | 2008 -09 | 2009 -10 | 2010- 11 | 2011 -12 | 2012 -13 | 2013- 14 |
|-----------------------------|--------------------------|-------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Australia | 8.4% | 13.7% | 7.7% | 10.0% | 11.0% | 15.8% | 15.5% | 18.3% | 17.5% | 14.0% | 10.8% |
| New South Wales | 6.8% | 11.3% | 5.7% | 5.8% | 6.4% | 8.1% | 17.7% | 20.3% | 14.8% | 13.4% | 8.5% |
| Queensland | 11.1% | 13.8% | 5.8% | 11.5% | 18.7% | 14.7% | 6.8% | 17.2% | 22.6% | 16.8% | 16.6% |
| South Australia | 8.5% | 8.5% | 7.8% | 6.7% | 4.7% | 7.1% | 14.8% | 12.9% | 9.6% | 4.9% | 8.5% |
| Tasmania | 6.2% | 11.7% | 20.7% | 13.2% | 10.2% | 9.3% | 11.0% | 8.7% | 17.4% | 8.1% | 6.9% |
| Victoria | 9.9% | 13.4% | 11.7% | 18.6% | 17.8% | 9.6% | 16.3% | 10.9% | 13.4% | 12.7% | 9.7% |
| Western Australia | 10.3% | 12.4% | 14.1% | 8.2% | 11.8% | 9.8% | 3.5% | 20.4% | 18.6% | 10.8% | 15.9% |
| Big Bash teams (avg) | | 11.0% | | | | | | | 12.8% | 10.4% | 10.3% |
| Average | 8.7% | 12.3% | 9.7% | 10.3% | 11.4% | 11.1% | 12.8% | 15.9% | 16.0% | 11.6% | 10.8% |

The injury prevalence has significantly increased for all teams in the T20 era (RR 1.41 95% CI 1.37-1.45) and every individual team, other than South Australia, also has significantly increased in prevalence.

Table 11 – Injury prevalence by player position 2005-06 to 2013-14

| | Av 96-7 to 04- 5 | Av 05-6 to 13- 14 | 2005- 06 | 2006- 07 | 2007- 08 | 2008- 09 | 2009- 10 | 2010- 11 | 2011- 12 | 2012- 13 | 2013- 14 |
|-------------|---------------------------|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Batsman | 4.4% | 7.2% | 6.4% | 5.4% | 7.0% | 6.7% | 7.3% | 9.1% | 9.2% | 5.6% | 7.8% |
| Keeper | 2.0% | 5.1% | 3.0% | 0.5% | 1.7% | 3.0% | 9.0% | 8.0% | 13.6% | 1.2% | 3.2% |
| Pace Bowler | 15.2% | 19.9% | 14.4% | 18.8% | 18.8% | 19.7% | 21.0% | 24.2% | 25.0% | 19.8% | 16.9% |
| Spinner | 4.1% | 7.2% | 8.5% | 4.0% | 9.9% | 3.8% | 3.5% | 10.8% | 10.4% | 10.8% | 4.7% |

Although pace bowlers remain the most susceptible to injury by far, they have actually had a smaller relative increase in injury prevalence in the T20 era compared to the other positions (i.e. batsmen, spin bowlers and wicketkeepers have had relatively greater increase in missed time in T20 era than pace bowlers).

Table 12 – Relative injury prevalence by player position comparison between eras

| | Relative risk T20:preT20 injury prevalence | 95% CIs |
|-------------|--|-----------|
| Batsman | 1.64 | 1.53-1.75 |
| Keeper | 2.57 | 2.10-3.14 |
| Pace Bowler | 1.31 | 1.27-1.36 |
| Spinner | 1.77 | 1.60-1.97 |

As per Table 14, the notable injury categories which led to more missed playing time in the T20 era were:

- Other (not tendon) shoulder injuries RR 1.55 95% CI (1.35-1.78), most likely to be traumatic injuries such as shoulder instability;
- Wrist and hand fractures RR 1.35 95% CI (1.21-1.52);
- Side and abdominal strains RR 1.48 95% CI (1.33-1.65);
- Lumbar stress fractures RR 1.69 95% CI (1.56-1.84);
- Thigh and hamstring strains RR 2.08 95% CI (1.90-2.27); and
- Shin and foot stress fractures RR 1.75 95% CI (1.52-2.00).

Of these only hamstring and shoulder instability injuries have been shown to have a statistically significant increase in actual incidence. The increased prevalence of the other injuries is therefore due mainly to increased severity (greater number of matches missed per injury). The greater number of matches in the T20 era has led to an injury of a given time period missing a greater number of games as there are more games in this given time period, on average.

The notable injury categories which led to less missed playing time in the T20 era were:

- Medical illness RR 0.55 95% CI (0.47-0.66); and
- Arm/forearm fractures RR 0.38 95% CI (0.24-0.62).

Table 13 – Comparison of injury prevalence by body area

| Body region | Av 96-7 to 04- 5 | Av 05-6 to 13- 14 | 2005- 06 | 2006- 07 | 2007- 08 | 2008- 09 | 2009- 10 | 2010- 11 | 2011- 12 | 2012- 13 | 2013- 14 |
|---|---------------------------|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Fractured facial bones | 0.1% | 0.1% | 0.0% | 0.0% | 0.1% | 0.2% | 0.1% | 0.0% | 0.1% | 0.0% | 0.0% |
| Other head and facial injuries | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Neck injuries | 0.0% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Shoulder tendon injuries | 0.5% | 0.5% | 0.8% | 0.7% | 0.4% | 0.5% | 0.5% | 0.0% | 1.2% | 0.7% | 0.0% |
| Other shoulder injuries | 0.4% | 0.6% | 1.0% | 0.5% | 1.1% | 0.2% | 0.3% | 0.5% | 0.5% | 1.0% | 0.3% |
| Arm/forearm fractures | 0.1% | 0.0% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Other elbow/arm injuries | 0.2% | 0.3% | 0.2% | 0.0% | 0.4% | 0.6% | 0.7% | 0.6% | 0.5% | 0.0% | 0.0% |
| Wrist and hand fractures | 0.5% | 0.7% | 0.6% | 0.2% | 0.5% | 0.3% | 0.8% | 1.4% | 1.4% | 0.6% | 0.8% |
| Other wrist/hand injuries | 0.2% | 0.3% | 0.1% | 0.1% | 0.6% | 0.1% | 0.3% | 0.5% | 0.4% | 0.4% | 0.1% |
| Side and abdominal strains | 0.6% | 0.9% | 0.3% | 0.6% | 0.8% | 0.8% | 0.9% | 1.3% | 1.1% | 0.9% | 1.1% |
| Other trunk injuries | 0.1% | 0.2% | 0.3% | 0.1% | 0.0% | 0.0% | 0.5% | 0.1% | 0.1% | 0.2% | 0.2% |
| Lumbar stress fractures | 1.0% | 1.7% | 0.9% | 1.6% | 0.8% | 0.8% | 2.1% | 2.7% | 1.7% | 1.5% | 2.6% |
| Other lumbar injuries | 0.7% | 0.8% | 1.1% | 0.6% | 0.5% | 1.3% | 1.0% | 1.2% | 1.0% | 0.2% | 0.3% |
| Groin and hip injuries | 0.6% | 0.7% | 0.6% | 1.0% | 0.7% | 0.4% | 0.3% | 1.2% | 0.6% | 0.6% | 0.7% |
| Thigh and hamstring strains | 0.8% | 1.6% | 0.3% | 1.1% | 1.6% | 2.3% | 1.5% | 1.1% | 2.3% | 2.0% | 2.3% |
| Buttock and other thigh injuries | 0.0% | 0.2% | 0.0% | 0.8% | 0.1% | 0.4% | 0.1% | 0.1% | 0.1% | 0.6% | 0.1% |
| Knee cartilage injuries | 0.7% | 0.9% | 1.7% | 1.0% | 0.6% | 0.3% | 1.3% | 1.5% | 0.4% | 0.4% | 0.5% |
| Other knee injuries | 0.4% | 0.6% | 0.6% | 0.3% | 0.4% | 0.5% | 1.5% | 0.4% | 0.6% | 0.4% | 0.4% |
| Shin and foot stress fractures | 0.3% | 0.6% | 0.2% | 0.4% | 0.4% | 1.0% | 0.2% | 1.0% | 1.1% | 0.7% | 0.5% |
| Ankle and foot sprains | 0.5% | 0.6% | 0.5% | 0.6% | 1.6% | 0.5% | 0.3% | 0.7% | 0.6% | 0.2% | 0.1% |
| Other shin, calf, foot and ankle injuries | 0.6% | 0.8% | 0.2% | 0.4% | 0.5% | 0.8% | 0.3% | 1.3% | 2.1% | 0.8% | 0.5% |
| Heat-related illness | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Medical illness | 0.4% | 0.2% | 0.3% | 0.2% | 0.3% | 0.1% | 0.2% | 0.3% | 0.4% | 0.1% | 0.1% |

Table 14 – Injury prevalence categories significant changes between eras

| Body region | Significant change in prevalence | Relative risk T20:preT20 era injury prevalence | 95% CI low | 95% CI high |
|---|----------------------------------|--|------------|-------------|
| Fractured facial bones | No | 1.24 | 0.87 | 1.79 |
| Other head and facial injuries | No | 1.50 | 0.75 | 3.00 |
| Neck injuries | Down | 0.39 | 0.19 | 0.79 |
| Shoulder tendon injuries | No | 1.09 | 0.96 | 1.23 |
| Other shoulder injuries | Up | 1.55 | 1.35 | 1.78 |
| Arm/forearm fractures | Down | 0.38 | 0.24 | 0.62 |
| Other elbow/arm injuries | Up | 2.16 | 1.77 | 2.63 |
| Wrist and hand fractures | Up | 1.35 | 1.21 | 1.52 |
| Other wrist/hand injuries | Up | 1.27 | 1.05 | 1.52 |
| Side and abdominal strains | Up | 1.48 | 1.33 | 1.65 |
| Other trunk injuries | Up | 2.34 | 1.78 | 3.08 |
| Lumbar stress fractures | Up | 1.69 | 1.56 | 1.84 |
| Other lumbar injuries | No | 1.09 | 0.99 | 1.21 |
| Groin and hip injuries | Up | 1.16 | 1.03 | 1.30 |
| Thigh and hamstring strains | Up | 2.08 | 1.90 | 2.27 |
| Other thigh/buttock injuries | Up | 6.25 | 4.33 | 9.03 |
| Knee cartilage injuries | Up | 1.20 | 1.09 | 1.33 |
| Other knee injuries | Up | 1.46 | 1.28 | 1.67 |
| Shin and foot stress fractures | Up | 1.75 | 1.52 | 2.00 |
| Ankle and foot sprains | Up | 1.15 | 1.01 | 1.30 |
| Other shin, calf, foot and ankle injuries | Up | 1.25 | 1.13 | 1.40 |
| Heat-related illness | No | 0.00 | | |
| Medical illness | Down | 0.55 | 0.47 | 0.66 |

5 Discussion

5.1 Workload

Bowling workload has been documented as a risk factor for overuse injury in cricket [23 30-32]. Acute high one-off workloads [30], overs or sessions per week [31 32] and workload variability[23] have all been associated with increased risk of bowling injury, with low weekly workloads also documented as a risk factor[31]. Although our understanding of high (and low) workloads in bowlers as risk factors is gradually improving, the ability to avoid high and low match workloads and particularly sudden upgrades of workloads is diminishing, as T20 matches and first class matches are scheduled more closely to each other on an annual basis. In athletics, it would be considered a grave training error for a runner to upgrade from running 10km per week to 100km per week [33], yet this is the equivalent of the rapid workload upgrade now expected of some fast bowlers. It has been shown in cricket that sudden upgrades in workload are associated with increased injury risk[23] although it is harder to adequately prepare players in the fashion which is 'low risk'. That is, maintaining a constant moderate workload (not too high and not too low) to both condition but not overload. Sadly the modern schedule encourages the two extremes (unloading in T20 and overloading in first class cricket) for fast bowlers who want to play in all forms of the game.

At domestic level a major change in the schedule occurred in 2013-14 with the domestic one day competition being held as a stand-alone fixture at the start of the cricket season. This substantially reduced the number and frequency of format changes (moving back and forth from one day to Shield) for players. In theory, this format change for the domestic one day competition should assist in reducing the number of workload variations and hence injuries. In practice, 2013-14 showed lower injury rates than in previous years and we hope that this trend will continue if the new format remains in place.

5.2 Recommended change of injury definitions

This report is still based primarily on the 2005 cricket consensus definitions. It can and will be used as a discussion point at the 2015 World Congress on Cricket in Sydney, to recommend changes to a new set of consensus definitions. In particular the major items that need consideration for change are:

(1) New injury definitions for tournament cricket to allow comparison of tournaments like World Cups [34], IPL, Big Bash, including some recording injuries which require medical treatment but do not cause missed playing time. The primary recorders of injuries have been the team doctors and/or physiotherapists for the six states, T20 franchises and the Australian team. Recorders have been encouraged to enter most injuries that have presented to medical staff into the AMS but with the injury survey coordinator deciding (based on missed game, or players not continuing in a game) determining threshold for qualifying as a significant injury. This may allow comparison with international studies of particular tournaments as no other country is recording annual injury statistics to the level of Australia.

(2) An ability to differentiate injury prevalence in matches only (currently used and laborious to calculate) from daily injury prevalence at all times (easy to calculate)

automatically from systems such as the AMS). Match injury prevalence is more important and accurate but the ease of calculation of daily injury prevalence for all teams/countries will make this a useful reference figure. The use of the AMS data tracking on a day to day 'availability to play' basis, at an individual level (i.e. regardless of which team the player is in) gives a quick snapshot and a view across the time of the season in injury prevalence (this data has been presented earlier). While these numbers will have some equivalency to the game missed prevalence has historically been the measure to allow year to year comparison. It is also worth noting that for the next few seasons at least, AMS daily "injury prevalence" does not yet have a historical dataset for comparison. The injury survey match "injury prevalence" still has utility in comparing modern injury rates to the recent past (i.e. last 15 seasons). In this sense the AMS functionality now allows a very speedy answer to the question "how are injuries tracking in Australian cricket *at the moment?*" whereas the injury survey gives a slower but more accurate answer to the question of "how do the injury rates of last season compare to other years in the modern era?". Although the focus of injury severity has been "missed playing time", better analysis of "missed days" will allow us to determine how much the increase in missed playing time is simply due to a more compacted schedule.

(3) Change in injury categories. Due to increase in shoulder instability, hamstring strains and hip joint lesions, these items need separate (distinct) injury categories in future reports. Although not common, concussion needs a separate category for political reasons. There could be a rationalisation of heat-stress injuries into the medical illness category as it is such a rare event.

(4) Other items related to T20 cricket. For example, in the 2005 definitions a bowler was defined as a player who regularly bowled 5 or more overs in matches, which would not allow any T20 specialist player to be considered a bowler. Seasonal incidence calculations since 2011-12 (using the previous methodology) have effectively resulted in a change in results. This is because Australian players are now contracted to two distinct teams in domestic first class and T20 cricket. Prior to 2011-12, if, say, a NSW state player suffered an injury that caused him to miss Shield games and Big Bash games, for seasonal incidence calculations it would count as one injury (for NSW). However, in 2011-12, if a NSW state player suffers an injury that causes him to miss Shield games for NSW and then also, say, Big Bash T20 games for the Adelaide Strikers, it necessarily counts in the seasonal incidence statistics for both (distinct) teams. This anomaly is better than the alternative of ignoring injuries which occurred in another format of the game. It does further reflect that injury prevalence (% of players missing through injury) should be considered the 'headline' injury rate for comparison from season to season.

(5) Potential change in squad definitions. For Cricket Australia, under the current definitions the season starts with a contracted list of under 20 players but by the end of the season over 40 players are under surveillance. It may be worth considering adding players only to the cohort for the format under which they play (so that a non-contracted CA player who plays a T20 match is not part of Test team injury surveillance for the remainder of the season).

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